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SCALE OF ENTERPRISE AND STRUCTURAL CHANGE IN BRITISH PIG FARMING

BY
DAVID JUCKES

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FOREWORD

Whenever the scale of enterprise is discussed, be it pigs or any other form of economic activity, the question of the relative efficiency of large and small scale units arises. In other words, is there any evidence that increasing returns to scale do actually occur? As Heady has remarked with regard to agriculture – "The only empirical studies which have been made to test returns to scale in agriculture suggest either decreasing or constant returns. Even then these data cannot be taken as conclusive evidence.... Until more conclusive data are derived, the exact nature of returns to scale for any segment of agriculture will remain unknown".

Nowadays poultry tend more and more to be kept by large specialist producers and there are indications that pig production has started to move in the same direction, for instance, between 1962 and 1965 the proportion of sows and gilts in breeding herds of more than twenty, to total sows and gilts, increased from 44·7% to 54%. In view of the continuing interest of this Department in the well-being of pig producers and the contribution of the home pig industry to national well-being, it was considered that it would be useful to examine this development in the light of the relative efficiency of large and small scale pig farming.

However, considerations of scale in isolation are not likely to lead anywhere unless they are seen in the context of other factors, such as changes in the geographical distribution and developments in the various fields of integrated production. The purpose of this study, then, is to show where and in association with what systems of farming pigs are produced; to discuss developments, such as specialist pig farms divorced from other agricultural enterprises, vertical integration and pig groups; to examine some large pig units and the results of an enquiry among large herds. Finally, in the course of the report, an assessment is attempted of the effects of scale on the factors influencing the success of pig production.

The study has been made possible through the provision of funds by the Pig Industry Development Authority to support a temporary Fellowship in the Department for research into some aspects of pig production economics. This report marks the conclusion of a two-year period of study by Mr. David Juckes which terminated in September 1964 when he accepted an appointment with O.E.C.D. in Paris. The delay in publication has been unavoidable.

S. T. Morris,
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I

THE CHANGING STRUCTURE OF BRITAIN'S PIG INDUSTRY

In their examination of British agriculture, Astor and Rowntree (1938) described developments which had taken place up to then in British pig farming. They pointed out that the pig population had remained remarkably steady from 1870 to 1910, although there had been an expansion in numbers in Cornwall, Suffolk, Lancashire and around Edinburgh, balanced by a fall in numbers in the rest of Scotland and the hill counties of Wales. After a drastic fall in numbers during the Great War, a fall that necessarily takes place in wartime and was even more marked during the Second World War, being due to the fact that pigs compete directly for human food, the recovery was most marked in the Eastern counties of England and Scotland, probably due to arable farmers searching for more profitable lines of production. In the Highlands and most of Wales the decline continued. In 1933 the Pigs Marketing Scheme caused a 40% increase in the number of Pigs in Great Britain.

They emphasised the fact that pigs in Great Britain were essentially a supplementary enterprise, not dovetailed in with other enterprises to the extent as was the case in Denmark for example. They suggested that pigs were found in potato growing areas and near large towns. In addition they suggested that pigs tended to be kept to utilise by-products such as tail corn in East Anglia, fruit in Kent and skim milk in Lancashire, Cheshire and Cornwall.

Discussing the future of pig production in Great Britain they asserted, correctly, that the future of dairy farming lay in liquid milk production and there would be no place for pigs utilising by-products. They argued against the imposition of import controls to protect the pig industry. In particular they stressed the supplementary nature of pig production and that it was not an integral part of British agriculture, being largely dependent on imported foods.

There is little indication of changes in the geographical distribution of pigs since Astor and Rowntree (1938) described it. Table 1.1 compares distribution in 1928 with that in four years since the war.

Table 1.1

PROPORTION OF SOW HERD IN GREAT BRITAIN IN EACH COUNTRY AND REGION

Regions	1928	1954	1958	1962
	%	%	%	%
Highlands	0·33	0·45	0·25	0·26
North East	1·26	2·40	2·10	2·66
East Central	0·87	2·06	1·76	1·49
South East	1·10	1·67	1·54	1·49
South West	1·95	2·53	2·06	1·81
Scotland	5·52	9·11	7·74	7·73
Northern	7·66	9·03	9·01	8·93
North Western	11·18	14·25	12·97	12·23
Eastern	20·02	15·29	15·00	16·89
East Midland	6·35	7·20	6·70	6·35
West Midland	9·33	7·81	8·77	7·99
Southern	6·10	6·72	7·25	7·64
Mid Western	6·06	6·03	6·85	6·89
Far Western	8·34	7·50	8·93	9·32
South Eastern	11·47	11·79	11·70	11·40
England	86·51	85·62	87·20	87·63
North Wales	3·43	2·99	2·98	2·65
South Wales	4·53	2·28	2·09	1·99
Wales	7·96	5·27	5·07	4·64
Great Britain	100·00	100·00	100·00	100·00

Source : M.A.F.F.

The regions shown in this table are Milk Marketing Boards' regions. The figures are shown in this way because it was necessary in order to investigate the connection between milk production and pigs. Milk figures are only available by regions. The first three years shown are all peaks in the well known pig cycle. Nineteen hundred and sixty-two should have been another being four years after 1958, but due to price policy did not really develop as such.

The trends observed by Astor and Rowntree (1938) are still largely the same. There was some reversal in the earlier years after the 1939-45 War, but this was probably due to meat rationing. For example, in 1948 almost all farms kept at least one pig.

There is little evidence to show changes in the distribution of pigs but there are quite marked local differences in their occurrence. Astor and Rowntree (1938) talk of by-product utilisation. Does this really explain the geographical distribution of

pigs ? It has often been noticed that pigs are associated with milk production. This remains true in spite of the fact that by far the greater part of British milk is sold liquid. Lewis and Welsby (1964) have shown that even in the South West skim and whey contribute a negligible proportion of the feed requirements of the pigs in the area. This suggests that some less direct explanation than a simple utilisation of by-products is involved, such as, for example, comparative advantage.

The profitability of an enterprise can vary for three broad reasons. The inputs or factors of production can vary in cost. The selling price of the output of final product can vary. Finally the technical efficiency with which the inputs are used to produce the output may vary. Now when deciding whether wheat or barley, or even wheat or beef, will be produced in a given area these effects cannot be considered for one possible product in isolation. The other alternative must also be considered. If the area A is much better than area B for growing wheat it does not follow that area A will be a wheat growing area. It may be even better for growing barley. Area A may be very good for producing beef but transport costs may keep down the selling price so that it is better to grow wheat. In the case of pigs the problem can be simplified. On the whole if a farmer keeps pigs he does not deny himself the opportunity to follow other forms of agriculture. If he grows wheat in a field he cannot grow barley. But broadly speaking pigs do not use land. We can, therefore, ignore the effect of alternative products. We will make passing allowance for them by specifying that the prices charged against a possible pig enterprise would be opportunity costs. The opportunity cost of more feed is the price it costs to buy it, because it is readily available. The opportunity cost of labour is not always the hourly wage, as will be shown later.

Now pig selling prices vary very little throughout the country. There is a slight tendency for them to be lower away from the centres of population where the final product will be eaten but centres of population are quite widely spread and Britain is a small country with a relatively efficient transport system. Similarly pigs are kept, apparently efficiently, in all parts of Britain and technical efficiency does not seem to be higher in the warm South than the cold North. Housing costs may be slightly higher in the latter but when spread out over a few years of production the difference is negligible.

It is clear then that the reasons for the geographical distribution of pigs must be sought in the regional difference in input prices.

When maps showing the location of pigs and other crops and stock are drawn various possible relationships can be seen. The connections with milk production have been mentioned. Pigs also occur in corn growing areas, particularly barley areas. They do do not on the other hand occur together with sheep. It is also known that pigs are kept on small farms. The following table shows this.

Table 1.2

DENSITY OF PIGS ACCORDING TO SIZE OF HOLDING ENGLAND AND WALES, 1962

Size of Holding (acres)	Total Pigs		Breeding Sows	
	Per 100 acres	Percent of total pigs in national herd	Per 100 acres	Percent of total sows in national herd
0 – 4	189·80	7·0	22·91	6·3
5 – 19	84·52	12·8	11·28	12·7
20 – 49	35·62	13·8	5·02	14·5
50 – 99	19·60	15·7	2·79	16·7
100 – 149	15·88	11·1	2·18	11·4
150 – 299	14·91	19·8	1·99	19·8
300 – 499	13·80	10·1	1·69	9·2
500 – 999	14·76	7·5	1·86	7·1
1,000 & over	10·44	2·2	1·45	2·3
All holdings		100·0		100·0

Source : M.A.F.F. Raised results of a one-third sample of June 1962 Agricultural returns for England and Wales.

An analysis was, therefore, made of the relationship between the pig density in the regions shown in Table 1.1 and milk production, barley acreage, sheep numbers and size of holding. It emerged that there was a statistically significant relationship between pig numbers and all the other measures. Pigs were at a higher density: (1) as the density of milk production increased, (2) as barley growing increased, (3) as the density of sheep decreased, and (4) as the farms were smaller. But this was too simple an approach. It is difficult to see why pigs and sheep should not occur together. It has been said that the greatest enemy of a sheep is another sheep, not a pig. It is more reasonable to suppose that the relationship with barley is correct and that sheep graze on mountains where barley cannot be grown.

Because of the relationships between the possible factors explaining the pig density the relationship between them and pigs was calculated simultaneously by a multiple correlation (see Appendix 3). It was then seen that the sheep density was not significantly related to the pig density. Sixty-five per cent

of the variation in pig density was explained by the other three factors: barley acreage, milk production and farm size, that is, that pigs are kept in barley producing areas, dairy areas and areas of small farms.

The inputs to a pig enterprise are food, labour and permanent equipment. It is not difficult to see why barley producing areas would have lower feed costs. This is analysed in more detail later but briefly it seems clear that cheaper rations may be produced by grinding and mixing one's own corn. Savings nearly as great may be possible if grain is purchased from a neighbour without the services of a merchant but to transport grain long distances both merchant and transport costs will usually be incurred. It is not conceivable that small farms obtain food more cheaply than large but is there any advantage to dairy farms ? It has traditionally been assumed that milk by-products such as skim and whey explain the association between dairying and pigs. As discussed above it has been shown that even in the South West these contribute a negligible proportion of the feed requirements of the pigs in the area. No doubt they are locally important but not sufficient to explain the association. There is the possibility that a grinding and mixing unit could produce food for pigs and cows and thus share the cost, but feeding home-mixed rations is less common with cows than pigs and thus unlikely to be important.

The labour factor on the other hand, could well be important in explaining the association of pigs with both dairy and small farms. On a dairy farm the characteristic of the labour requirement is daily peaks at milking and feeding but little seasonal variation. Most important, the work must be done seven days a week. There are thus times of the day when there is labour available for jobs that have to be done daily. Arable farms on the other hand have high peaks at sowing, cultivation, and harvest. Extensive stock rearing also has such peaks, for example, lambing. Therefore, pigs and poultry keeping, with jobs that have to be done each day, will fit in very well with dairying. Small farms are largely manned by family labour and, particularly as income is usually restricted, such labour will work long hours without overtime and weekend rates being charged. The farmer's own labour is of course included here, being no doubt the most important. On larger farms all labour costs will be charged in full. Furthermore as the labour force gets larger it will be increasingly possible to allocate all time available usefully without any discontinuities.

On smaller farms there may be buildings available that can usefully be used by pigs. This sort of thing is much less common on larger farms. Without the spare labour that there may

be on smaller farms, herds will tend to be sufficient for one whole-time man and buildings for such herds will not be available except in competition for other uses. Furthermore it may be easier to get farm improvement grants for the addition of a small piggery than for putting up a large specialised unit. The tendency for smaller farms to be owner-occupied may make it easier to provide pig housing. This is the sort of investment at which landlords often look askance.

There is also a consideration that may prevent large farms keeping pigs that may be regarded in one way as irrational. The larger scale entrepreneurs will be paying much higher taxes than the small farmer. As taxes are only paid on profits and therefore any extra profit does add to his income it may be regarded as irrational for the large scale farmer to fail to develop an enterprise that could do so. But in fact he may well choose, perfectly rationally, to take his satisfaction in other, untaxed, ways. The labour that could tend pigs may keep the farm tidy instead. There are other minor reasons why pigs may be kept on small farms. A few sows running loose may cost very little in food, so far as any records appear at least, while they would be intolerable on a large farm. The farmer's wife may get the proceeds for the sale of weaners as pin money while the cost of food is borne by the farm. On the whole though, food costs would appear to account for the importance of barley production and labour costs for milk and farm size.

Up to this point we have considered the distribution of pigs described by Astor and Rowntree (1938). While the distinctive pattern of the thirties still broadly pertains, a closer look at the evidence would suggest that the reasons for this distribution are rather more complicated than the use of pigs to consume by-products. For the future this may be important because if by-products explained the present distribution we could perhaps expect a movement away from the present pattern into the "large buildings adjacent to mills on the quaysides of our principal ports" which Astor and Rowntree (1938) describe as "fantastic". They considered that such a development would be the logical conclusion of rationalisation. The foregoing partial explanation of the present distribution of pigs, together with other points in this report, suggest that such an arrangement would be "fantastic" rather than "rational" or "logical".

So far we have considered the distribution of pigs geographically. But pigs are kept on farms. To observe that pigs are kept in barley growing areas does not make it certain that pigs are kept on barley growing farms. In any given area there will be

many different types of farms. To discover on what types of farms pigs are kept farms must first be classified, a very difficult task as farms offer infinite variation and do not fit into neat slots.

Jackson et al (1963) classified farms in the Eastern Counties and found that excluding specialist pig and poultry farms, pigs and poultry were more important on grain, grain with roots and mixed livestock farms and less important on horticultural holdings. An advantage of their method of calculation was that pigs and poultry were not included in the process of calculation on the grounds that they are supplementary to the rest of the farm. Their results are shown in Table 1.3.

Table 1.3

PIGS IN THE EASTERN COUNTIES

Type of Farm	Percentage of all farms	PIGS AND POULTRY		
		Very Important	Important	Unimportant
Grain	10·1	18·6	31·2	50·2
Grain + Roots	15·9	16·3	34·5	49·2
Roots + Grain	15·2	7·0	26·0	66·9
Cash Roots + Hort.	9·9	4·7	26·6	68·7
Hort.	3·3	6·0	14·0	80·0
Cash Crops + Hort.	10·8	7·1	30·8	62·1
Dairy and Cash Crops	15·9	2·7	25·6	71·7
Mixed Livestock + Cash Crops	6·5	11·8	32·0	56·2
Dairy	7·9	6·3	26·4	67·3
Mixed Livestock	2·1	16·1	26·6	57·3
Pigs and Poultry	2·5	All groups except pigs and poultry		
TOTAL	100·0	9·3	28·5	62·2

The 1963 June returns were classified by the Ministry of Agriculture (1965) and the following table shows how the nat-

ional herd was distributed. This classification included pigs and poultry which explains in part the high figure in the mixed group. This same study showed that pigs were more important on dairy farms in Exeter, Bristol, and Manchester P.A.E.S. provinces than in others, on cereal farms in Leeds, Manchester, and Cambridge, and on general cropping farms in Leeds, Manchester, Cambridge, and Exeter.

Table 1.4

SOME ASPECTS OF PIG DISTRIBUTION BY TYPE OF FARMING, ENGLAND AND WALES

Type of Farming Group	Percentage of national pig herd	Average sow herd size	Percentage of pig farms which fatten only
	%		%
Predominantly Dairying	6·12	4·8	21
Mainly Dairying	15·36	7·4	18
Livestock rearing and fattening :			
Mostly cattle	0·66	7·1	36
Mostly sheep	0·61	5·1	36
General Livestock rearing and fattening	3·12	5·3	27
Predominantly Poultry	1·62	11·8	24
General Pigs and Poultry	13·74	34·3	17
Cropping (mostly cereals)	2·31	14·7	28
General Cropping	15·48	13·6	23
Predominantly Vegetables	0·34	11·4	27
Predominantly Fruit	0·50	13·0	24
General Horticulture	3·68	13·3	21
Mixed	20·35	11·9	16
Total full-time	82·88	10·4	23
Part-time	17·12	4·9	26
TOTAL	100·00	8·7	22

Source : M.A.F.F. Raised one-third sample of June returns. 1963.

The Farm Management Survey for England and Wales provides additional evidence of the dependence of different types of farming on pigs. For example, reference to these data show that pigs contribute 18% of the output on crops and livestock farms in Central Suffolk compared with only 3% on dairy farms in Kent and Surrey. A full analysis is given in Appendix I.

Apart from the type of farming with which it is associated the type of pig enterprise varies. An enterprise can sell weaners, buy weaners and fatten them or breed its own weaners and carry them right through for sale fat. There are also possible variations in the weight at which weaners change hands, indeed

they may be sold as heavy stores, and in the final product which may be pigs for pork, bacon or manufacturing. The gravest objection to purchasing weaners or stores rather than breeding them is the disease risk. Nevertheless about a quarter of all pig farms keep no breeding stock. It is likely that the separation occurs due to the different cost structure of the two stages of production, breeding and feeding. In the breeding stage labour costs and either housing or, if running outside, land costs are very significant. In the feeding stage food costs are overwhelmingly important. Probably much of the demand for weaners comes from those with a source of cheap food, such as swill, which enables them to fatten pigs very cheaply but would be no particular advantage for breeding stock. Often such food is available near centres of population where high land values would make it difficult to keep breeding stock. Care of sows on the other hand can be fitted in with milking or small-holding generally, thus keeping labour costs down. Housing costs are no greater with small numbers of sows than large, so it is economical for a small farm to keep sows while fattening would be impossible. Finally, where land is cheap either because it is hilly, as in parts of the West Country or because pigs fit into a rotation as sheep did in the past, as on the chalk downs of Southern England, outdoor methods of keeping sows can be used, producing particularly healthy pigs.

Table 1.5 shows the trend in size of breeding herds in recent years. There are no earlier figures available.

Table 1.5

CHANGES IN THE STRUCTURE OF PIG FARMING IN ENGLAND AND WALES, 1957 TO 1964

	1957	1958	1960	1961	1962	1963	1964
Percentage of all holdings which keep pigs	38·5	38·0	31·5	31·9	31·8	30·6	30·2
As a percentage of 1957 :							
Sow numbers	100	109	93	101	113	116	118
No. of herds 1 – 4 sows	100	98	77	75	71	65	59
No. of herds 5 – 49 sows	100	111	88	92	100	102	100
No. of herds 50 + sows	100	116	129	152	181	200	236

N.B. 1959 is not available.

Source : M.A.F.F. Raised one-third sample of June returns.

The first line shows that there was a sharp drop in the proportion of farms keeping pigs. The table also shows that it was

the small enterprises that went out of business and stayed out. The medium-sized also went out but came back in again, while the number of large herds continued to rise in spite of adversity. By 1964 nearly a quarter of all sows were kept in herds of 50 sows or more*. To keep the matter in proportion, however, at the same time the average sow herd size had only reached 9·5.

It is not difficult to suggest reasons for large herds staying in production even in the face of a fall in prices. Compared with smaller herds many more of them have heavy investment in specialist housing and equipment. Thus their fixed costs form a larger proportion of their total costs than is the case of small herds. It is possible that profits show a greater degree of variation in small herds than in large herds and consequently there will always be a number making only a very small profit which quickly changes to a loss. Finally where the pigs contribute only a very small proportion of the profits they will be abandoned much more quickly than where they used to contribute a significant proportion and it is hoped that they may do so again.

There are other changes in the structure of pig farming which are taking place or may do so in the future. "Factory farming" is a subject that has received plenty of publicity for a variety of reasons, some well-founded and others emotional. It is not proposed to deal here with animal welfare as this has been done elsewhere. There are two facets of "factory farming". One is pure size of unit, though this is not usually referred to as "factory farming" unless the animals are confined to specialist-type buildings. The other aspect is separation of the animal production enterprise from other agricultural enterprises and usually from the breeding of young stock.

The simplest case of vertical integration is of course on the farm, as has already been stated. Weaner pigs may be bred on the farm on which they are fattened or sold to someone else to fatten. Likewise, the food to feed the pigs may or may not be grown on the same farm.

Outside the farm vertical integration may occur in either direction, back to the origins of the food or forward to the slaughter of the pigs, their processing into bacon and the like and final sale. There is also another rather special case of integration to be discussed elsewhere, which is the production of breeding stock. It is well known that genetic improvement can only be achieved by using large numbers and rather than

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* Between 1962 and 1965, the proportion of sows and gilts in breeding herds of more than 20, to total sows and gilts, increased from 44·7% to 54%.

bringing together a large herd there may be a more or less loose form of integration, the actual breeding or at least its planning being carried out centrally.

It is possible that a pig food manufacturer might seek to own pig enterprises to consume his product. If the price of pigs and food moved independently he could insure against low food prices in this way as he would then make a correspondingly large profit on the pigs. While the food price formula operates to determine pig prices this is in general not valid in Britain. However, the food price formula is calculated from the raw materials of compound foods and ownership of the consuming firms could be very valuable in the event of a price war between competing manufacturers. It is suggested in another chapter that no firm can secure a supply of food more cheaply than a farmer with his own grain grown on his farm. A food firm with spare capital might find it profitable to buy pig farms and thus be in a stronger position than competing manufacturers but it is unlikely that they could produce pigs more profitably than the more successful farmers.

It is also possible that a bacon factory, a meat processing firm or even a wholesaling or retailing group might wish to secure its supply of pigs by owning the producing enterprises. All firms such as this have high capital investment and a very rapid turnover so can ill afford to be short of supplies for any length of time. Where retail supplies are concerned the importance of brand image is involved. A product missing from the shelves for any length of time may be very difficult to sell thereafter. By vertical integration the firm will avoid having to pay high prices to secure its raw material.

A processing firm might also be tempted to establish vertical integration in order to control the quality of its raw material. In terms of pigs this means genetic improvement and particularly uniformity and control over feeding to achieve the desired objective. It is possible that these both might be achieved better by direct control than by market forces, particularly as the measurement of the results, in the form of quality in the pig carcase, has proved somewhat difficult.

There is however, a very considerable difficulty in the way of this. For the enterprise to be worth consideration a significant part of the supplies of pigs to the firm concerned would have to be produced. This would involve a very large fattening unit indeed. It is likely that the disease risk would be increased. In addition this fattening unit would need two main raw materials.

The first is a supply of weaners. To breed these within the enterprise would involve a vast organisation with even bigger disease risks. Management to secure an even supply of weaners would become acutely difficult. The other alternative would be to purchase weaners. This would again increase the disease risk. Also, if a large number of weaners have to be purchased in a relatively restricted area it is likely that the price will rise. This may cause an increased production of weaners and a return of the price to normal but alternatively it may remain inflated. Which happens may depend upon the confidence of potential weaner suppliers that there is a reliable market outlet. The processing firm might find itself in difficulties if there were a drop in the price of its end product. To maintain the weaner price would involve financial loss but to reduce it might endanger the supply of weaners. A processing firm buying pigs from farmers breeding and fattening their own pigs might find them much more ready to accept a temporary drop in prices, because of their fixed investments than weaner producers with little investment except sows.

The second raw material is of course food. It should always be possible to obtain a supply of compound pig food, but in so far as it is true that cereals grown on the same farm are the cheapest source of food the integrating firm would be at a disadvantage unless producing its own cereals. This would require an even more vast organisation.

There is one other rather special aspect of integration, though this is integration with the rest of farming rather than with other parts of the pig production chain. These latter are only affected in so far as it makes the scale of their possible integration even more vast. It is the problem of muck disposal. Fattening pigs produce vast quantities of it and while it may be very beneficial once it is on the land it is expensive to get it there unless the land is very close. A farm with crops and grass to use the muck may gain profit from its use but if a pig unit has no land it may be found that the best that can be negotiated from nearby farmers is permission to spread the muck on the land for nothing, spreading costs being borne by the pig unit. Another aspect is that liquid pig muck is more or less offensive. It may in some circumstances be difficult to disregard local objections to its use. If straw must be used this will generally cost more to buy than on a corn growing farm.

It is often suggested that because broiler production shows marked vertical integration the same must happen with pigs. Henry and Macmillan (1960) point out that full-time meat processors can offset fluctuations in supply of one type of livestock by out-of-step fluctuations in supply of another, which is

not the case with broiler processors. Their argument is less convincing in Britain than in the United States as in this country bacon factories are more dependent on pig supply alone. They also point out that price and production risks are not so high in other forms of livestock as in broilers. Here it may be pointed out that broiler rations are still much more accurately formulated than pig rations and much more critical, removing a reason for integration with the feed firms.

Continuity of supply and even improved quality may be sought by means of contracts with producers, such as those offered by Walls and F.M.C. This avoids the necessity for closer integration. Short term falls in price may not reduce supplies if the producers wish to maintain a contract they regard as favourable. Good public relations can also establish an identity of interest between processor and supplier. Walls seem to have been particularly successful at this. In addition both these two have entered the field of genetic improvement for their suppliers.

Another form of structural change has been the development of Pig Groups. This has already been the subject of a report published by P.I.D.A. (1964). It is not proposed here to cover the ground again but to discuss the implications of the report and its recommendations.

The report lists four main types of group.

a) Weaner groups which concern themselves in the main with the link between weaner producer and feeder.

b) Feeder groups which concern themselves in the main with the link between feeder and factory.

c) Groups which to a greater or lesser extent seek to link several processes.

d) Groups involving fairly heavy capital outlay, e.g. in co-operative feeding units.

The main benefits to be obtained from the weaner groups are steady prices, a reduction in marketing and transport costs, a reduction in disease risk both by inspection before sale by some competent authority and by reducing contact with other unknown pigs, maintenance of supplies in swine fever outbreaks and a closer link between feeder and breeder leading towards the supply of weaners suitable for the ultimate trade of the feeder.

It can be seen that these benefits may tend to overcome some of the disadvantages of a separation between the stages of pig production and thus where there are other reasons for separating the stages the development of such groups will facilitate the process. It will, however, cost something to run a group and there

will thus have to be some reason for separating the stages, such as has been suggested, before it will be profitable to do so.

Feeder groups may obtain benefits for their members by negotiating group contracts and level delivery bonuses such as they might not obtain individually, by helping their members to improve carcase quality and promoting the sale of this for improved prices, by organising transport to the factory and thus reducing its cost, by organising a supply of suitable weaner pigs, by buying food in bulk, and by encouraging recording and improved management amongst the members.

The integrated group clearly will attempt to provide all or some of these benefits at the same time and may be able to organise the transfer of weaners to a very high order.

The groups involving capital outlay could be a large scale breeding unit or a co-operative fattening unit. In the former case a group could carry out a constructive breeding programme as a result of the number of sows in its members' control. This could be very attractive. Whether it would cost its members any less to do this than to purchase improved stock from breeders, is open to doubt. The possibility of joining a breeding group would reinforce the point that there are unlikely to be economies to scale due to breeding by making them available to smaller scale producers if they do occur.

The co-operative fattening unit would seem to offer advantage only when there are some special circumstances in its favour. An example is the Anglesey Quality Pig Group for which there is a supply of skim milk. It would obviously be expensive to take this to a number of small enterprises but it can provide a cheap food fed centrally. It seems unlikely that these developments will occur in the absence of some such special set of circumstances.

All these possible activities of groups seem admirable and no doubt will continue to spread. It is not proposed to discuss them further except in regard to weaner groups.

There are still over twenty per cent of pig enterprises in the country without breeding stock. Therefore, the transfer of weaners or stores to the fattener is important and any plan to improve it likely to be profitable. But there is an increasing tendency towards enterprises including all stages of production. There are very good reasons for this.

There will be many cases where separation of stages of production is highly profitable, for example, extensive breeding on pasture and fattening near towns or other sources of cheap food. Any scheme facilitating transfer of stock from one to the

other must be of benefit. But there is no reason to try to reverse the tendency towards reasonable sized pig herds containing all stages of production and large enough to get full benefit of any economies to scale.

II

INCREASING SCALE IN PIG FARMING

ECONOMIES TO SCALE. GENERAL.

According to the "law" of diminishing returns, returns to an input factor tend to diminish at some point when other factors are held constant. If, however, the inputs of all factors of production are increased in the same proportion there are three things that could happen to output: (a) it could expand in the same proportion as the inputs – constant returns to scale; (b) it could expand less than in proportion to the inputs – decreasing returns to scale, or (c) it could expand more than in proportion to the inputs – increasing returns to scale.

Now it is obvious that keeping more and more pigs in one pig house is not an increase in scale. Eventually a point will be reached when there is over-crowding and each extra pig will add less to profit than the last pig. A point may be reached where the pigs are so over-crowded that total profit falls. The pig house is a fixed factor. The problem is one of variable proportions, pigs to pig house.

In considering scale it is supposed that the most profitable number of pigs in a pig house has already been determined and the question is how many more pig houses to build. But it must be remembered that as Lipsey (1963) says, it is always possible to define inputs in such a way that only constant returns are possible. Such an approach will not help in developing a theory useful in studying the causes and consequences of returns which do not in fact prove to be constant when all objectively observable and measureable inputs are varied.

It is not the purpose of this report to develop a theory. It is to study the causes and consequences of large scale pig farming, but it is necessary to decide exactly what is a large scale pig farm, or pig herd, or pig enterprise. It is not just a farm on which there are a large number of pigs in one place. Land is an important input and its proportion can be varied. The more there is the less dense the pigs will be. It is not just a farm on which each pigman looks after a large number of pigs. Labour is another input. It is not just a farm on which one man manages a lot of pigs. More managers can be hired. Kaldor (1934) found that the fixed factor limiting the size of firms is co-ordination because this is a function that can only be achieved by one brain. A large pig farm, then, is one on which overall co-ordination is maintained over a large number of pigs.

Having said this it must be remembered that the statistics considered in the last chapter did not show exactly this point. It would be possible for one farmer to have control over a large number of holdings as shown in the June returns. But if the number of pigs per holding is increasing it must also be true that the number of pigs per farmer is increasing. It is a sufficient condition though not a necessary condition.

A purist may point out that some aspects of "bigness" considered here are questions of variable proportions. It would be particularly easy to exclude all consideration of disease problems on these grounds. Nevertheless, the problems are going to be discussed whatever their economic classification.

Economies to scale can be divided into external and internal economies, the latter being subdivided into pecuniary and technical economies. External economies are those which apply to the industry as a whole, for example a large pig industry may give rise to large scale, efficient processing facilities. These external economies only affect the individual pig enterprise in so far as one location may have advantages over another due to the large number of pigs already there. Participation in an A.I. scheme, proximity to a factory, etc., could arise from this cause, quite separately from the effects of proximity to ultimate consumers.

Technical economies to scale are concerned with physical relationships or technical efficiency, for example, farrowing rate, conversion rate and the like, genetic improvement and disease.

Pecuniary economies to scale include costs of inputs, in this case, largely food, selling price of product, cost of capital equipment and risk.

The fact that the average size of pig herd is increasing and large herds becoming more important does not in any way suggest that there are economies to scale or even that in a more general way large pig herds are more efficient than small ones. A large firm may produce more income for the operator than a small one, so there is an incentive to enlarge regardless of the effect on unit costs.

If it is now profitable to have large pig herds it may be asked what reason can be given that they did not exist to the same extent in the past. In part no doubt this may have been due to technological barriers that no longer exist. These would include the ability of farmers to manage such herds. In addition growth takes a finite time. Farm firms have a finite life usually bounded by the lifetime of the farmer. The farm may continue but the

specialised knowledge that built it up is to a great extent lost. There will be economies to existing firms which wish to increase in size as compared with new large firms that might be set up. It will almost certainly be easier for the former to acquire capital. Expenses in setting up the increased part of the firm may be much lower than for a new firm. The availability of breeding stock in the case of pigs is an instance of this. Taxation policy may favour growth with investment allowances and the like.

SCALE AND PROFITABILITY.

There have been more studies of this question in North America than in Great Britain. Bauman (1961) in a study of 118 pig herds in Indiana in 1956 and 1957 found the following variation.

Table 2.1

COST PER HUNDREDWEIGHT OF HOGS AT DIFFERENT ENTERPRISE SIZES (INDIANA, U.S.A. 1956/7)

Size of enterprise	Under 25 sows			25 - 49 sows			50 or more sows		
	Most Efficient	Av.	Least Efficient	Most Efficient	Av.	Least Efficient	Most Efficient	Av.	Least Efficient
No. of enterprises	10	52	10	10	53	10	3	13	3
Total costs $	12·85	16·49	20·01	12·75	15·14	19·19	11·36	14·01	16·51

Source : Bauman (1961).

As can be seen, while there was a tendency for the larger herds to have lower costs the spread within each size group was very wide. The reduction in costs was due to labour and capital. The figures for labour were rather unreliable since the measuring stick used for quality and amount of labour was a rather crude one. The drop in capital was largely accounted for by buildings and equipment. The larger enterprises did not get higher prices for their hogs.

Arrick and Purcell (1962) found that the cost per hundredweight of pork produced fell with increasing size of herd due to increased labour and capital efficiency.

Norin and Johnsson (1964) using costings collected in Sweden found that costs per fattening pig dropped from 287·50 kr. to 249·30 kr. as the size of batch increased from 20 pigs to 1,000. Of this reduction 24·35 kr. was reduced labour costs, 9·20 kr.

reduced housing costs and 4·60 kr. lower food prices. The drop in labour costs seems to have been due to the fact that not until a level of 1,000 pigs was reached was one man fully employed.

For the United Kingdom, evidence is scanty, but in recent years information relating to pig production has been available from studies undertaken by various University Departments of Agricultural Economics.

For the years 1956/7 - 1957/8 these were assembled by P.I.D.A. (1961). The margins per £100 output in herds of various sizes are shown in Table 2.2

Table 2.2

PROFITABILITY OF DIFFERENT SIZED HERDS

Size of Breeding Herd / Margin per £100 Output	Number of Sows					
	1-9	10-19	20-29	30-39	40-49	50 +
1956/57	14·9	18·7	20·3	14·3	15·6	17·1
1957/58	12·7	11·5	15·5	12·5	13·8	12·0

Source : P.I.D.A. 1961.

There are no clear trends apparent.

A possible reason for this is that comparisons of different pig herd sizes are made difficult by the fact that management levels vary with the size of herd. The best managers tend to be with the largest herds. One way to overcome this difficulty would be to compare the same herds at different stages in their growth. Changes in prices could be discounted by choosing herds that had increased in size and others that had decreased. The trouble is that these latter are almost impossible to find. Pig herds almost always get bigger. The only reduction in size is their liquidation, after which of course there are no costings to consider.

SCALE AND FACTOR COSTS

P.I.D.A. run feed recording schemes for both breeding and feeding stock. The herds recorded are not chosen in any way by P.I.D.A., co-operation being entirely voluntary and the sample in no way represents a cross-section of the industry. Table 2.3 shows the results of an analysis of the feed recording the results for the periods 1.10.61 – 31.3.62 and 1.4.62 – 30.9.62. Regressions

for each factor on size of breeding herd were calculated. The regression coefficient is shown together with its standard error when the former is larger than the latter. No conclusions can be derived about other coefficients.

Table 2.3

REGRESSION CO-EFFICIENTS OF CERTAIN FACTORS ON SIZE OF BREEDING HERDS
(Standard error shown in brackets)

	1961 - 62 (140 Degrees of Freedom)	1962 (150 Degrees of Freedom)
2. Conversion	–	–
3. Cost per cwt. meal equivalent (feeding herd) Shs.	– 0·027 (0·007)	– 0·024 (0·006)
4. Pence per pound liveweight gain	– 0·0083 (0·0057)	– 0·0064 (0·0046)
5. Litters per sow per annum	– 0·0025 (0·0009)	– 0·0011 (0·0008)
6. Pigs born per litter	–	–
7. Pigs reared per litter	–	–
8. Pigs reared per sow per annum.	– 0·016 (0·009)	– 0·0098 (0·0079)
9. Percentage loss of weaners	– 0·049 (0·024)	–
10. Average weight of weaners lbs.	–	–
11. Meal equivalent per pig reared lbs.	–	–
12. Food cost per pig reared Shs.	–	–
13. Cost per cwt. meal equivalent (breeding herd) Shs.	– 0·021 (0·007)	– 0·027 (0·008)
14. Meal equivalent per pound of weaner Shs.	–	–
15. Cost per pound of weaner, food costs Shs.	–	–
16. Percentage of pigs in premium grades Bacon herds only	– 0·097 (0·053) (101 D.F.)	– (102 D.F.)

– Statistically unreliable, no conclusions can be drawn.

Source : P.I.D.A. feed recording scheme. 1.10.61 – 31.3.62, 1.4.62 – 30.9.62.

As can be seen most factors are not significantly affected by the size of herd. The cost of meal in both fattening and

breeding herds did decrease with increasing size of herd, in each case at rather over £2 per ton for an increase in size of herd of 100 sows, which is of economic as well as statistical significance. In one period the litters per sow per year decreased with increasing herd size but there was no significant effect in the other. The drop was rather over 0·2 litters per sow per year with an increase in herd size of 100 sows. However, there was no significant relationship between pigs weaned per sow per year and size of herd, and this is the important measure. In one period the percentage of pigs lost before weaning appears to fall with increasing herd size but there is no significant effect in the other. That is at variance with the common opinion that in small herds more individual attention can be given to breeding stock. Perhaps more expensive permanent equipment in the larger herds offsets this. The period when the herd size had an effect was over the winter months. On the other hand an examination of the individual data shows that while the larger herds tend to have loss figures near the average there is a much greater variation amongst the smaller herds. No doubt there are many small herds achieving the individual attention to sows traditionally attributed to them.

(i) **Food:**

In order to investigate the relationship between the prices of food and conversion rate the results of the P.I.D.A. feed recording scheme already mentioned were analysed. It was found that high food price was to some extent offset by a low conversion rate showing that the food had more value. Nevertheless in both periods the cost of food per pound liveweight gain in the fattening herd was significantly correlated with both conversion and price of food, suggesting that cheaper foods were still on the whole more profitable. In a multiple correlation the price of food added significantly to the variation explained by conversion rate. Table 2.4 shows their relative importance, measured by beta coefficients.

It must be remembered, however, that errors in measuring any variable in an analysis of this type can affect the result. If too low a price were charged for home grown food through omitting some of the processing costs, this would increase the significance of the price in explaining variation in cost of liveweight gain.

Table 2.4

RELATIVE IMPORTANCE OF FACTORS EXPLAINING THE VARIATION IN FOOD COST IN PENCE PER POUND OF LIVEWEIGHT GAIN

Explaining factor	1961 - 62	1962
	All herds	
Conversion	0·896	0·916
Food costs	0·537	0·538
	Bacon herds	
Conversion	0·883	0·900
Food cost	0·501	0·563

Source : P.I.D.A. feed recording scheme, 1.10.61 – 31.3.62, 1.4.62 – 30.9.62.

The cost of food is influenced by considerations both of scale and of the type of farm on which pigs are kept, as discussed in the first part of this report. Before reaching any conclusions about these it is first necessary to consider the relative costs of home grown, home ground-and-mixed, and purchased feeds.

Milling and mixing, using small automatic plant costs about £1 per ton. This does not include labour costs, which are often negligible, the building in which the machinery is housed, which may be available free, or may need an additional charge nor opportunity costs for the capital. Quite small units are now available. It is certain that a forty sow herd is large enough to justify a unit even if sow food and creep food are purchased. The minimum herd size may well be smaller particularly if other use can be made of the unit.

If ready-mix concentrates are purchased and added to the cereal fraction a saving of about £4 per ton of food can be made compared with the cost of ready prepared compound foods. It is normally suggested that this is due to exorbitant prices charged by the manufacturer and his vast profits. This is certainly not true. His rate of return on capital may be quite high but even if it is his rate of return on turnover will be only one or two per-cent and this is the maximum saving possible even if all profits were foregone.

The most important saving is in avoiding transferring the grain from one farm to another. The producer avoids both trans-port charges and merchant's fees. These latter include an element for credit and bad debts. Even if the farmer has to bear some credit charge because he holds his grain beyond the point at which he might reasonably sell it the cost to him of his grain will never be greater than that paid by the compounder. The price of home grown grain is determined largely by import prices. The compounder pays the port price for the imported grain, being

often located at the port. The price of grain on the farm will then be the port price less transport costs and it is this that the farmer must pay as he is nearer the source of supply. Only when no grain is on the home market can imported grain be cheaper.

There are a number of large scale pig enterprises unconnected with a grain growing farm. These have to decide whether to buy cereals and other foods to grind and mix or a ready-prepared compound food. Clearly the advantages of home-mixing are less marked but may still be appreciable. The effects of scale on the price paid may be different in the two cases. Their costs can be compared on the one hand with smaller enterprises of the same type, that is specialist pig holdings, and on the other with pig enterprises integrated with cereal producing farms.

The simpler case of a large specialist unit buying compound foods may be considered first. As compared with an enterprise on a cereal producing farm its costs will be higher to the extent already indicated above in this chapter. Compared with a smaller but similar enterprise it may be possible to buy food more cheaply but not very much so. A seller may cut his price for large quantities for two reasons. First he may do so because for one act of selling he is making a greater absolute level of profit. It has been suggested earlier that the manufacturer is unlikely to be making a margin of more than one or two percent and therefore any cut he may be prepared to make is unlikely to be significant. The merchant who acts as middleman might be getting about 30/- per ton passing through his hands. It would be wrong to think of this as profit. Part of it will be transport and office costs. If an enterprise were large enough to persuade a firm of feedingstuffs manufacturers to deal with it direct the merchant's office costs and profit could be saved but in fact as the manufacturer will be organised to sell through merchants the saving may only be slight. There are possibilities of handling and transport savings. A merchant who buys lorry-loads of sacks of food, unloads them, and then delivers them in small quantities round to a number of farms is bound to have higher costs than one who can buy a full load of one food and send it direct to one farm. There will then be savings to pass on to the purchaser. Bulk handling of food offers possibilities of savings but at present these are not great. The majority of food is prepared for sale in sacks and it can mean interrupting the flow of production to fill a bulk lorry. This no doubt will develop. Both these savings will in any event run out at the point where delivery can be taken of a complete load of sacks or one bulk lorry.

There is one saving that may be made where a cereal grower does not in fact grind and mix his own food. Lorries can be used to carry pig food in one direction and grain in the other thus saving transport costs. This may make it less attractive for an enterprise in a position to grind and mix its own food to do so, but this saving will only occur when there is the possibllity of obtaining the same saving by grinding and thus will not affect the type of farm on which pigs are kept. This complimentarity in transport costs can also affect the price of grain to a pig enterprise in an area of the country with a deficiency of grain. One can imagine a vegetable holding in Cornwall for example selling in Covent Garden and returning lorries bringing grain purchased in the grain growing areas of the Eastern counties.

The case of a large pig enterprise separated from grain growing which, however, grinds and mixes its own food can now be considered. Comparing it first with a similar smaller enterprise, costs of grinding might clearly be rather less. This saving is unlikely to be considerable since the development of small efficient mill-and-mix units. A herd smaller than the capacity of the smallest of these may have higher costs but once the size is up to the one ton size, which can be justified at about 40 sows, further savings will be slight. There may be savings in the price of ingredients for milling. If proteins, minerals and vitamins are bought as a ready-mixed concentrate the same considerations apply as to buying compounds, but there are two points at which discounts may be more important. On the one hand the margin allowed to the merchant is sometimes a good deal higher per ton than for compound food and, therefore, the discount he in his turn will allow for quantity may be higher. On the other the size of load at which transport and handling economies will run out will be higher as the concentrates form only a proportion of the ration. There may be similar economies in delivering the cereal part of the ration. It is possible also that the grain may be bought more cheaply than the smaller pigs-only enterprise can do.

Compared with a cereal-producing farm the position of the large pig enterprise without cereals looks less favourable. The savings on concentrate additives will run out at not very large herd size and in any event the price of concentrates is of comparatively little importance as their contribution by weight to the ration is slight. It is difficult to imagine circumstances where a large farm without cereals could buy the cereals it needs more cheaply than a farm producing its own. With the operation of the deficiency payments scheme the selling price of grain off the farm, which is the opportunity cost to the farm who in fact feeds it to pigs, is usually lower than the port price of similar grain.

In conclusion, it appears that food costs are unlikely to be lower for any other form of pig keeping than on a cereal-growing farm mixing its own rations. Economies to scale will run out at the level at which a mill-and-mix unit is economically employed. With units now available this may mean quite a small herd. Producing food for other classes of stock in the same mill may also be possible. It is certainly feasable to run a mill-and-mix unit for 40 sows and it may be a very much smaller number. It is only the man with very few sows who will be totally unable to use one. On the pig enterprise without cereal growing they may continue to a higher level. In order to keep a sense of proportion it should be remembered that the pig enterprises going out of business recently have been of one to four sows size and these have certainly some of them suffered diseconomies due to their small scale. They may have been unable to mill-and-mix economically and have had to buy compound foods at a retail price.

(ii) Labour:

It is commonly held that it is not worth economising on labour costs as labour is so small a proportion of the total cost of producing pigs. Wragg (1959) points out that on average it requires only 3 percent loss in feeding efficiency to offset the whole of the gains arising from a 25 percent saving in labour. However, his results indicated most clearly that productivity is not in any way adversely affected by the exercise of the most rigorous economies in labour use.

Adam Smith in his "Wealth of Nations" after showing how division of labour in pin-making greatly increases the productivity of labour lists three reasons why this should be so: "the increase of dexterity in every particular workman", "the saving of time which is commonly lost in passing from one species of work to another" and "the invention of a great number of machines which facilitate and abridge labour, and enable one man to do the work of many". But he points out that agriculture "does not admit of so many sub divisions of labour", "the spinner is almost always a distinct person from the weaver; but the ploughman, the harrower, the sower of the seed, and the reaper of the corn, are often the same".

Increased dexterity is hardly of such importance in looking after one stage in the production of pigs as it is in making pins. The saving of time in changing from one job to another could indeed be important were it not that certain jobs with livestock have to be done at set times of the day, week or season and cannot be done early even though time be available. It often fits in well to tend the breeding stock at one time of day and

the feeding stock at another. But as between pig keeping and other types of farm work both these considerations apply. The best pigman is he who spends his whole day at it. Much time may be wasted in, for example, going to do a few hours ditching in time spare from pig work. This suggests that there will be economies to scale in labour use up to the point at which one man's time is fully used.

But there are some jobs which can be done more economically by two men than by one alone. Furthermore as stock, particularly breeding stock, have to be tended daily, having a working force of two men is a great deal more flexible in arranging time-off than is a one man unit. This is not so true on a mixed farm where men from other jobs can stand in for the pigman but there may then be a loss of efficiency. It is unlikely that economies to scale in respect of labour use continue much beyond a herd that can be managed by two men, perhaps about one hundred sows and their progeny through to slaughter.

The limit can be lower still where the work on pigs can be fitted in with other work to advantage, achieving a degree of complementarity. Possibly pigs are sometimes kept on small dairy farms for this reason; they can be fed between milkings. But often the reason must in fact be supplementary; they are one of the few enterprises that can add to output. In general though, there will be economies in labour costs up to the point where one man is fully employed and possibly up to the point where two men are fully employed. As the work of a man is to some extent indivisible labour costs may rise not only when there is work for half a man but also for one and a half men, two and a half and so on.

It is difficult to get accurate figures for labour costs when only part of a man's time is being spent on pigs. In any correlation analysis an error in measuring labour will increase the apparent correlation with margin. The margin will appear to be high, because insufficient deduction for labour cost has been made, at the same time as labour is too low because of mis-measurement. It is, therefore, of more interest that labour costs are not correlated with other measures of efficiency than that they are negatively correlated with margin. Wragg (1959) found no economies to scale in labour costs. The Swedish study already mentioned that did find labour economies only went as high as full-time work for one man. Visits to a number of large pig units throughout the country and a questionnaire, circulated to a number of large pig enterprises, have revealed no tendency to labour economies to scale.

Labour saving methods of feeding and mucking-out have received considerable attention. The breeding part of pig production does not lend itself to much labour saving and the labour costs on fattening pigs are too low to admit of much saving. However, both mucking-out and feeding can be mechanised to save enough labour to cover the costs of installation with perhaps a modest margin and as mucking-out is unattractive and feeding a great nuisance at weekends and holidays it may in time be necessary to mechanise in order to get labour. The mechanisation should show economies to scale at least up to a certain point and this may well later lead to large size fattening units.

It has just been said that the breeding side of pig production does not lend itself to labour saving methods. However, by changing the system entirely considerable labour saving may be achieved. Such a system is that widely known as the Roadnight system. Langmead (1964) describes one. The sows run outside in a large herd, one hundred to two hundred. They farrow outside with the minimum of attention and in cheap housing. He quotes permanent equipment for a hundred sow herd at £21.9s. per sow, excluding land. It is a very healthy system and fits in well with large scale arable farming on free draining land. One man can look after a herd of up to two hundred sows which is a very considerable labour economy. The system was studied by Blair and Reid (1965). They found that man-hours per sow per year were only 18·2 for the Roadnight system compared with 35·8 for the conventional systems. On costs and production they found the Roadnight system better. They reported that doubts were expressed about the grading of the resulting progeny due to the Wessex blood commonly found in sows under this system. They were unable to confirm this and found one enterprise using Landrace cross Large White sows successfully.

While it is possible to run a system such as this with a smaller herd of sows the full economies of the system are unlikely to be realized. As the sows will be fed in fields far from the buildings travelling time will be high per sow with a small herd. Transport must be provided and will be in part a fixed cost. It will be less easy to integrate a pig herd into a mixed farm without loss of other output on a small farm than on a large farm. Probably then such a system will lead to larger breeding herds.

Labour costs for farms costed by Cambridge and Exeter 1959-61 and similar figures from a variety of centres for the years 1956/7 and 1957/8 show no tendency towards increasing or decreasing labour costs. However, it must be remembered that these are costing figures of labour and will not necessarily reveal any complementarity in labour costs between pigs and other enter-

prises. At the lower end of the scale where labour costs might be most interesting they are likely to be least accurate.

In a questionnaire to operators of large scale enterprises, questions were asked about size of herd and labour costs. It was particularly aimed to discover any low labour costs due to large size. In breeding and feeding herds it is fairly common for there to be at least 50 sows per pigman and this is by no means always accompanied by labour saving methods. There were some cases of around one hundred sows per pigman or even rather higher. It is difficult to say whether this can be achieved in the long run without a loss of efficiency and all those reporting figures such as these had expanded their herds fairly rapidly over the past few years. It seems unlikely that with a breeding and feeding herd much over fifty per man is reasonable but it would be unwise to suppose that some people will not achieve considerably higher figures without loss of food utilisation efficiency. It was commonplace a few years ago to hear that labour figures achieved in New Zealand dairy herds couldnnot be expected in this country, but this would no longer be held in the light of results now seen. It would seem then that there may be economies to scale in labour costs up to the size at which one, or possibly two, men are fully employed but little thereafter. On the other hand the number of sows at which this occurs may be expected to increase somewhat. At the other end of the scale, whether there are diseconomies or not depends on how well pig work can be integrated with work on other enterprises.

(iii) Capital:

The cost of capital, the interest on it, in the form of permanent equipment, is not of great importance in determining variation in the costs of pig production. A farrowing house may be built for £120 per sow. This is occupied for rather over eight weeks. Dry sow accommodation is needed for the remaining four months until the next litter. This might cost £30. Systems can be devised for lowering these figures considerably. Thus each litter has two months interest on £120 and four months on £30. These are equivalent to a year's interest on £20 and £10 respectively, making £30 in all. At a rate of interest of 10%, a reasonable rate to a landlord, the charge to each litter would be £3, in the region of 8/- per pig. A good fattening house can easily be provided at £15 per pig place. This might be occupied for three months at most. The interest charge would be then another 8/- per pig. It may be said that 16/- per pig is by no means negligible but it is not likely that there will be such variation in this figure due to scale of production that it will produce appreciable economies or dis-

economies to scale. It may be rather cheaper to build 20 sow houses than 10, but not much. At the lowest end of the scale the proportional saving will be greater as one whole wall is shared between two pens. In fact savings possible due to new systems, quite apart from considerations of scale, are likely to swamp the latter.

A farmer with a limited amount of capital may well think that to state that capital costs are unimportant is sheer lunacy. He will want to spend his capital so as to bring him the maximum personal income, though other satisfactions may well affect the decision. He will want to keep as many pigs as possible for a given sum and once the buildings and other permanent equipment are provided will want to use them to full capacity. In fact it will be worth his while to sacrifice margin per pig if this means an increased total margin. But this is simply a matter of variable proportions. Capital is then a limiting factor. When comparing relative profitabilities between large and small herds, as is being done here, it is only the relative interest charges that should be considered.

Uncertainty may impose a limit in the situation where more capital could readily be made available or even where the capital is in fact available. This is uncertainty in a financial sense rather than due to disease or increased chances of someone dropping a cigarette end in the straw. Adam Smith in his "Wealth of Nations" has pointed out that men will readily risk a small amount in the hope of winning a larger when the adverse probability (known or estimated) against winning is much in excess of the ratio of the two amounts, while they commonly will refuse to incur a small chance of losing a larger amount for the virtual certainty of winning a smaller, even though the actuarial value of the chance is in their favour. The implication of this is that a farmer may be unwilling to increase the size of a possible loss even though the chance of the loss will thereby be reduced. Knight (1921) discusses grouping and specialisation of risk-bearing as ways in which increasing size may reduce risk. To the individual farmer, however, the level of his equity is more likely to be important. That is the proportion of the total capital at risk which belongs to him. As his equity falls for a given level of loss on the total investment he loses a larger proportion of his own capital. Since a bankruptcy is irretrievable, the entrepreneur will be running an increased chance of losing all his capital, for a given chance of loss, the lower his equity falls. But this visualises all entrepreneurs with a fixed limit for risk capital in mind and is really again introducing the point of variable proportions.

Disease risks in larger herds may in fact mean that more expensive buildings are constructed in large herds than in small

and this could well wipe out any economies in building costs. This is further discussed in the section on disease.

Labour saving devices may be worth installing in large herds but here the interest charges are offset by the saving in labour costs. Again the fact that capital may limit the size of a particular herd has nothing to do with the comparative costs of herds of different sizes.

Opportunity costs of limited capital are perhaps more realistic than accounting costs. But it is not possible to say that a small herd will be paying a higher or lower opportunity cost than a large herd. This will depend on the individual circumstances of the farms and again on the limitations on supply of capital.

A great part of the capital investment in a pig enterprise is in the animals themselves. Food is bought for them and consumed over some time before there is any product ready for sale. But it is very difficult to make standards of comparison for this sort of investment. It may be possible to avoid paying for much of the food until near the time for selling the pigs even without losing discounts. Continuous or batch methods of production have a considerable bearing on this. The F.M.C. are prepared to make quite generous advances against fattening pigs. With all this there is no indication that the large enterprise will get its working capital any cheaper, or more expensive, than the small enterprise.

(iv) Disease:

It is not easy to decide whether pigs in large or small herds are more liable to disease. In order to decide whether or not there are diseconomies to scale due to disease it is necessary to decide how the risk to any one pig varies according to the size of the herd in which it is kept. Once an infectious disease has entered a herd of pigs the chances of other pigs catching the disease are very high. It might well be argued that the larger the herd the more chances there are of disease entering the herd. On the other hand, others might suggest that a large herd can be more easily self-contained, particularly as regards breeding stock, and thus have a reduced disease risk. It might be that in general, hygiene is better in large herds than in small. An appeal to facts must be made.

Swine fever is the easiest disease to investigate as there are records available of numbers slaughtered since the introduction of the eradication policy. Ministry records show that the average number of pigs slaughtered per outbreak is about four times the average size of herd in the country. Contact pigs are also slaughtered and these are included in the one outbreak but during

the period April-June 1964, contacts represented only 17% of the total number of animals slaughtered on account of swine fever during the period. It is therefore, likely that the average size of herd slaughtered is in fact greater than the national average. This could be caused by the fact that outbreaks occur in the part of the country where herds are largest but for a reason unconnected with herd size. If this were the reason for the high size of outbreak it would be reasonable to expect the size of outbreak to be closely related to the size of herd in any given county. This is not so. The outbreaks occur in large herds in all parts of the country as well as the South East, where the greatest concentration of large herds is found.

In an attempt to overcome all these difficulties a multiple regression was calculated, attempting to explain the number of pigs compulsorily slaughtered per county in England and Wales during the period 11/3/63 - 31/3/64 as a percentage of the pigs in those counties at June 1963, by three factors of possible importance. These were pigs per 100 acres of land surface, average herd size and the ratio of total pigs to sows, which latter gives a measure of the importation of fattening pigs into the county. These figures were all those calculated for June, 1962 as they were already available and are fairly stable.

The ratio of total pigs to sows explained 43% of the variation in percentage slaughtered ($r^2 = 0{\cdot}43$) which was significant at 99·9% probability. The addition of size of herd increased the explanation to 48% ($r^2 = 0{\cdot}48$); the increase became significant at 99% probability. The density of pigs did not increase explanation significantly at either stage. All three variables were significantly inter correlated so it is not possible to say how much of the variation is explained by each factor. However, it would appear that both movement of stock for fattening and herd size are important and density of pigs unimportant.

It must not be overlooked that either of these factors might be correlated with other factors not considered but which are in fact the true causative factors. This is always true of regression analysis. It may be possible to give a more certain answer if details of individual outbreaks become available. Meanwhile it can be said that larger herds and herds buying-in weaners possibly have a greater risk of disease. This conclusion is in line with general opinion.

The extensive Roadnight system already mentioned in relation to labour costs is a peculiarly healthy system. Blair and Reid (1965) found that the number of veterinary calls per ten sows per year was 0·9 for the extensive system compared with 8·2 for conventional systems. Virus pneumonia has virtually no chance of

becoming a problem as unhealthy pigs die in the winter and conditions are ideal to prevent spread of the disease. There is no reason why any size limitations imposed by disease should affect this system.

It is possible to improve disease precautions. Elimination of disease organisms altogether and keeping them out of the herd are a possible approach. Virus pneumonia (V.P.P.) free herds have been built up from disease free stock kept clear of other stock. A rather more recent development is in herds from pigs produced by hysterectomy. Diseases transmitted to young pigs by the sow after birth can be eliminated in this way. There are problems connected with rearing such pigs and all has not gone well in this respect in this country but it is not the place of this report to review these. The continuing problem with both V.P.P. free herds and Minimal Disease herds is to keep them free of disease in the long run. The diseases which both approaches claim to eliminate are the respiratory diseases, such as V.P.P. and Atrophic rhinitis, and in addition it is claimed that skin diseases such as mange can be eliminated by the hysterectomy method.

These diseases are normally transmitted from one pig to another and can, therefore, be kept out of a herd by preventing entry of other pigs. Other diseases such as swine fever, foot and mouth disease and transmittable gastric enteritis can enter a herd on vehicle wheels, boots and the like. The risk to a V.P.P. free or Minimal Disease herd is the same in regard to such disease as to normal herds.

The disease free herd approach can affect problems of size of herd in three ways: cost of establishment might vary with size of herd, so also might cost of maintaining the disease free herd and finally the possibliity of being disease free might overcome restrictions on herd size that increased disease risk has tended to impose in the past.

The effect of costs of establishment of disease free herds is likely to be as an economy of growth rather than to scale as such. The principal cost to an existing enterprise is in income foregone while the change is taking place. The actual cost of obtaining disease-free stock will not be greatly affected by the size of herd it is intended to set up. But once a herd is established and it has been checked that the herd is disease free it may well be that the breeding stock will have their highest value in increasing the size of the herd and in so far as freedom from disease imparts benefits it will tend to cause disease free herds to grow in size.

As has already been made clear it is important to exclude other pigs in order to keep a herd free of diseases. There are various ways in which this will tend to be an overhead cost, being divided amongst an increasing number of pigs as the herd size increases. Protection against entry of pigs at the loading bay will have to be provided and will not increase as the number of pigs sold in the year increases. This risk will be best avoided when the enterprise provides its own transport taking pigs for sale and this will be cheaper per pig with a large herd. A thoroughly pig proof ring fence will be essential and the length of this will only increase at approximately the square root of the rate at which the area inside, corresponding to the size of herd, increases. Careful supervision is necessary to ensure that no unauthorised visitors come and the larger the herd the easier it will be to be sure that someone is always available. New blood will be needed in the herd, unless it is very large, but the cost of providing this will fall as the size of herd increases as it will be needed less often.

It is as well to bear in mind that many highly efficient and prosperous pig keepers do not have respiratory disease free herds and believe that the best results are obtained by building up immunity. A considerable amount of work has been done and experience built up concerning respiratory disease free pigs in North America but this may not be directly applicable to conditions in this country. Such work as has been done has not been very conclusive. Gordon (1962 and 1963) describes the effect on environment that different types of housing may have. In particular he contrasts the "McGuckian" and "Sweat-box" systems. He shows that of 1,000 lungs of pigs from the "McGuckian" piggery, from the "Sweat-box" piggery and from a random sample arriving at the bacon factory only 12%, 29% and 29·6% respectively were normal. As the "McGuckian" pigs were home-bred whereas the "Sweat-box" pigs were bought-in he concludes that the "Sweat-box" environment was controlling the spread of disease. But the most interesting thing is that even with these levels of disease, which are very high even with the allegedly controlling environment, good conversion rates and profitable results are obtained. Neither system is particularly successful in preventing the spread of disease but both enable the pigs to withstand it. Betts, Whittlestone, Beveridge, Taylor and Campbell (1955) found conversion rates of 4·28 for pigs with pneumonia and 3·55 for pigs without, in one experiment and 5·42 and 4·35 respectively in another. It is unlikely that the results in the "McGuckian" and "Sweat-box" houses discussed above were nearly as bad as the figures given here for diseased pigs.

Goodwin (1963) has described the effects upon profits when a fattening herd previously clear of pneumonia became infected and

was then cleared. These were spectacular. But in this case the breeding herd was kept separate from the fattening herd and was never infected. The fattening quarters were described as less than ideal so the young pigs on transfer from the breeding to the fattening farm were exposed to infection and a poor environment at the same time. This does not give any useful indication of the loss of efficiency due to respiratory disease in a herd in which it is endemic.

One is left with a feeling that it must be basically correct to eliminate disease as far as possible, some indications that this is a profitable thing to do, though far from certain of success, and finally that it might well remove limitations on size of herd imposed by disease risk.

(v) **Breeding and genetic improvement:**

Breeding policy for genetic improvement has been discussed in four articles by Jollans (1964). He quotes a list of heritabilities of various characters. On the whole the heritability of factors such as number of pigs born is low. He suggests concentrating on food conversion rate, growth rate and lean meat percentage if grading should be reorganised. He points out that biological normality, for example no leg weakness and ability to reproduce, is essential but the inheritance of this is complicated and it is much affected by environmental factors so, provided a pig is normal, attention should not be paid to small details.

He shows how large a herd is needed for a breeding programme. The F.M.C. pig development unit is to mate six boars to thirty-six gilts every ten weeks, though many geneticists would recommend a much larger herd size, say 300 to 500 breeding females. He points out the need for rapid turnover of generations. This will mean breeding from gilts.

Growth rate is comparatively easy to test but conversion rate needs individual feeding facilities. Carcase characteristics need co-operation of the factory or butcher.

All this leads to the conclusion that while a large breeding unit is needed, which could, as Jollans points out, be provided by a number of smaller breeders in a co-operative organisation, more than merely large numbers are necessary. A constructive breeding policy is inevitably fairly expensive and the results uncertain. Vertical integration with a factory can help in getting the carcase information needed. When this expense and trouble has been undertaken it is necessary to sell breeding stock in order to cover these costs.

It is a fact that usually greater improvements can be made in the field of management than in breeding. Even within breeding, crossing programmes involving two or more breeds can be carried out by quite moderate sized herds.

It is well known that genetic improvement of the male is more useful than that of the female. This is simply due to the fact that one male can be mated with many females. Therefore, a herd owner seeking improvement will pay well for a high class boar though it might not be possible to restock with high class females. Normally one boar is kept for twenty to forty sows. But more than one boar is normally kept even in herds where one would be sufficient for the number of services needed. This is partly in order to avoid close in-breeding and partly as an insurance in case one boar should prove to be infertile. The ratio of total sows for breeding to boars being used for service was 18·5 in June 1964, for example On the one hand a herd has to be quite small, say below 15 sows, before boar overheads begin to increase at all and on the other hand above about thirty sows the number of boars increases proportionately. It may be said that with a larger number of boars there is a a greater chance to select a good one but in fact on a commercial farm, as opposed to a pedigree breeding enterprise, by the time information on a boar is available the boar is often no longer obtainable. Most producers will base their boar purchases on such information as is available but will not select their boars further except to reject those infertile or carrying serious recessive defects.

There are some organisations producing, or planning to produce, hybrid female as well as male stock. Sometimes it is hoped to produce male and female lines that will "nick" in the same way as has been so successful with maize and more recently, poultry. Even if this should be achieved it can only be done by very large organisations. In that event the female stock would have to be repurchased for all replacements. A firm with such stock would have an advantage over those without it. But as has been suggested above, the costs of arriving at this position are high and it is doubtful if any firm would incur them without intending to sell the resultant breeding stock. It usually appears that this type of stock is not very much more expensive than reasonable normal breeding stock. Prices of fat sows are such that in fact good female stock may be purchased without adding greatly to the cost of producing weaners.

None of the above should be taken as an expression of an opinion that such hybridisation programmes will necessarily succeed about which many will have reservations, but merely as showing that the competitive position of the smaller unit may not be unduly affected if they do succeed.

Progeny testing in this country is to be rationalised, with the introduction of an elite herds scheme. With this, and possibly firms selling hybrid breeding stock freely, there is no reason to suppose that the smaller herd will have need to suffer any great disadvantage due to inferior stock genetically. The position of the smallest herds is rather more difficult. In order to avoid high boar overheads they will need to use premium boars and this may increase disease risk asmentioned in the last chapter. Clearly a good pig A.I. service would improve their position greatly.

(vi) Selling price:

With bacon pigs the price realised is usually largely determined by the quality and weight of the pigs. As size of herd increases it becomes easier to draw level pens of pigs and this may of itself improve quality. It may be worth separating gilts from hogs as the latter need more restriction of food if good grading is to be obtained.

For level quality pigs there is little difference in price. The pork market is less settled. Individual butchers may require porkers to their own specifications and may be prepared to pay quite highly for a guaranteed supply of the type they require.

Clearly quite often the best porker prices will be realised by small scale enterprises with close personal connections with a local butcher. With the development of super-market selling of meat the large scale porker producer might come to have an advantage but this is unlikely in view of the aggressive purchasing methods of such chains.

It is often suggested that large herds can obtain better prices by getting a level delivery bonus. In fact this is just the sort of benefit that pig groups can get for their members. Sometimes indeed, pig groups will get even better prices because by their very nature they are continually watching for opportunities of this sort but at the very least there are no advantages of this sort obtainable by a large herd that cannot be obtained by a group. Transport costs and marketing or procurement costs might be slightly lower for the big herd but this is unlikely to be significant.

In all, there seems little reason to suppose that size of enterprise will have any effect on selling price.

III

THE ORGANISATIONAL FEATURES OF SOME LARGE HERDS.

Some may think that the account in this report has been rather far removed from the realities of pig farming–sometimes dirty, wet and cold and always hard work. It is certainly true that statistics, however carefully they are collected, can mislead with their comfortable averages and clear trends.

In order to avoid this type of error two steps were taken during the work for this report. First, in 1964, a questionnaire was sent out to a list of farmers reported to have 100 sows or more* or to be specialist fattening enterprises selling at least 100 fat pigs per month. In the end one hundred and fifty-two usable replies were received which represented between 20 and 25% of the population of such herds. So far as could be ascertained there was no bias in the original sample or in the replies. Second, over fifty farms with large pig herds were visited in all parts of the country, in particular those with interesting features not altogether common. These fifty herds, and many other large herds described in the agricultural press from time to time, have been kept in mind while writing the report. Six of these farms are described briefly as case studies.

THE SURVEY RESULTS

Table 1 shows how the survey herds were distributed by type of farming and type of pig production. It is clear that large scale pig keeping is found associated with all types of farming.

Table 2 provides some information on the way sows were managed and fed. The systems vary quite widely but outdoor farrowing is relatively uncommon. As might be expected, pellet feeding is more common with the outdoor systems which, in turn, are associated with the sale of stores and weaners.

Table 3 shows the type of feed used on the farm and where it comes from, according to the farming system. It will be noticed that the percentages add up to considerably over one hundred as many get their feed from several sources.

Table 4 shows the type of feed used on the farm by type of pig production. In this case rather more detail is provided on milk by-products and on potato and swill feeding. As would be expected whey feeding is associated with fattening farms and skim milk with breeding and fattening. It is also rather interesting that while

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* In 1962, there were over 300 herds with more than 100 sows reported in the June census returns for England and Wales.

the percentage of fattening and breeding-and-fattening farms which use the "bulky" foods is similar the former use swill to a much greater extent.

Table 5 confirms what is general knowledge, that disease is more common among herds buying in weaners or stores for fattening than those which breed their own.

Table 6 shows how many different housing systems are used with large herds.

Table 7 produces the rather surprising fact that a quarter of all herds, excluding those selling weaners, muck out entirely by hand. The majority reported some hand work. Only one respondent put "Not likely" against the question.

Table 8 shows that the majority of these large herds have been growing in size over the past few years. This of course is in no way surprising in view of the fact shown earlier that the number of large herds has recently been increasing fast and these, no doubt, are more often smaller herds that have grown than large herds initiated as such.

In addition to the results shown here other information was obtained. Sixteen percent of these large herds are V.P.P. free and 4 percent MD or S.P.F. herds, founded by hysterectomy or from hysterectomy produced stock.

On the majority of the breeding and fattening herds, each full-time pigman looked after between 40 and 50 sows with their progeny. There were, however, an appreciable number who achieved up to, or even over, one hundred sows and progeny per man. Information was collected on assistance given, and housing, feeding and mucking out methods, but there was no real explanation on these lines for the very economical use of labour. Of course there is no information on the results achieved but other information suggests that economies in labour use rarely lead to falling efficiency. There is one point, that most of these herds have grown fast and it is just possible that these figures will not be maintained in future. It is much more likely that these herds show the type of labour use that will be common in a few years time. This reinforces the point made in the chapter on labour that the size of the herd at which maximum economies to scale in labour are obtained at present may well be exceeded in the future.

The results of this survey have reinforced an already held opinion that large scale pig herds are not in any way "special", and that the reason for their existence is more that an individual entrepreneur wants to increase his income, or counter-balance its tendency to fall, than that he expects to secure economies to scale.

CASE STUDIES

Herd 1

This is a specialist pig farm on about 30 acres of rather heavy, wet land. It is near two expanding towns and labour is difficult to get. The sows used to be kept out of doors but are now in on concrete. Of the one hundred sows about twenty are still outside because they either bully or are bullied. The sows are housed when dry in groups of about six, in eight small yards under an umbrella roof. Half the yard is covered by a low roof with a raised insulated sleeping area under it and on top of this straw bales are stacked up to the roof; there is a central feeding passage with four yards either side of it. Dry meal is fed into troughs along the walls of the passage and also scattered into the sleeping area. It is considered that the troughs are a mistake and that floor feeding would be better. There is a dunging area outside the sleeping area, not covered by the umbrella roof. The front of this takes off for mucking out with a front lift fork on a Fergusson tractor. This is done about once in six weeks. Straw is taken from the store over the sleeping area and thrown into both sleeping area and yard once a week. The sleeping area is cleaned out if dirty. The sows eat quite a lot of straw which at least seems to do them no harm. Plenty of straw is used as the manure is sold to a neighbouring fruit farm which likes strawy manure for blackcurrants. The sows are fed 6 lbs. of meal per day in one feed only. There is water in a trough fed by ball cocks but this only fills slowly and at feeding-time quickly runs dry. This compels the boss sows to stop feeding and thus allows the weaker sows to feed. The floor feeding also helps this. Certainly the sows look very even.

Either side of the dry sow yards there is a concrete apron and round this are modified Solari type farrowing houses. These are used in pairs, one with farrowing rails and a lamp in a railed area and the other with no rails and a creep feed. When the pigs are 3-4 weeks old the sow is moved from one to the other. These are open-fronted but shutters can be used in very cold weather. Feeding sows are only fed once daily.

Sows are tagged in the ear with a coloured tag by groups, with the object of keeping groups together so that sows rejoin the same group after weaning. At weaning the piglets go into a weaner pool. This mixes litters and from here they are split into smaller groups but never mixed again. In this weaner pool they get skim milk in the trough, ad lib. meal from a feeder and floor feeding as well. It is regarded as most important to give them a good start. The best eight pigs are drawn out first and the others may be left to catch up a little. Tail-biting occurs in the weaners' pool but stops in the fattening house.

In the fattening house the pigs are brought up to 4 lbs. meal and 2 gallons whey per day in summer or 4½ lbs. meal and 1½ gallons whey in winter, as quickly as they will take it. Then they get no more nor is there any other water available. They are fed twice daily.

The weaner pool and fattening house are fairly old wood-built buildings which will one day be replaced. Both keep warm. No very high hygienic standards are observed. Visitors are kept to a minimum but on the whole it is considered better to allow the pigs to build up a natural immunity to those diseases going around. B.coli has been serious in the past and seems to be connected with the outdoor sows.

Grain and concentrates are ground and mixed on the farm. This is always done by the farmer himself. The fattening ration is 16% protein. A conversion rate of 2·8 – 3·2 from weaning to slaughter has been found when tested but detailed records are not normally kept. Pigs average 172 days old at slaughter. Grading results are about 80% A under the old system. The pigs are sold on contract direct to a bacon factory. This contract is negotiated for this and certain other farms as a block contract. It is hoped that the factory will soon be able to supply the "C" and "K" measurements in the pigs in addition to the grading results at present given.

Sows average 8·5 – 8·6 pigs weaned per litter but only 12·5 pigs weaned per annum. This bad farrowing interval is clearly a weak point which it is hoped to improve. Only about 20 of the sows in the herd have full records kept, weaning weights, grading results, etc., and it is from these elite sows that breeding stock are kept. It was found that full records on all sows were giving too much paper work.

The farm is owned by the same family who run it but is in a different limited company, one being a land owning company and the other farming. For the purposes of accounts it can be treated therefore as a tenant farm. The tenant is rather favoured however as being his own landlord, his policy is rather different towards new buildings. The sow accommodation described earlier works out at about £30 per sow kept and might not have been supplied by many landlords.

Apart from the farmer there are two men on the farm and there is some secretarial assistance. The remainder of the farm is continuously cropped with barley and is manured with liquid effluent from the pigs. A tenant's capital of about £10,000 yields about £3,000 per annum if the farmer's own labour is charged in at agricultural rates. As a policy good profits are ploughed back as a safeguard against less good times. This is a high class spec-

ialist enterprise entirely committed to pig production. There are still a few weaknesses that can be cured in the face of falling margins. It is most unlikely to be driven out of production.

Herd 2

The firm has a large seasonal surplus of whey having gone into cheese making with government encouragement after the war. At times this whey can be sold as manufactured products such as lactose but at others there is little demand for it. It is expensive to dump and therefore, at these times it has a negative value. As whey feeding in particular produces large quantities of manure it was decided to keep the pigs on an integrated mixed farm. As the whey surplus was considerable a large number of pigs was needed and now about 500 sows are kept on each of 3 farms. The progeny go as bacon or cutters to the F.M.C.

As the project from the start was on a large scale it was clear that proper paper control must be maintained. There is a constant flow of information in both directions between farms and Head Office. Service dates, breeding policy, grading results, numbers of stock, food and the like are controlled in this way. Information in the form of analysed results is passed back to the farms from Head Office. From time to time, special investigations are carried out such as the effect of weaner weights on grading results and the causes of mortality in fattening pigs. Experiments on whey fed pigs have been carried out on the farm by Reading University.

It has been found that with a large enterprise such as this, one of the most difficult things to achieve is full production. In spite of the service plan, things easily go astray. Disease can upset the whole programme. At one time gilts bred on one farm were being transferred to the others. This was stopped by a swine fever outbreak and the whole breeding programme upset. Due to the large overheads carried by the pigs a drop in production affects profit considerably.

On an ordinary farm the amount of overheads apportioned to pigs tends to vary with the number of pigs kept and thus their importance relative to the rest of the farm. On this enterprise the overheads have to be carried by the pigs even when there is a fall-back in numbers.

The description of the system of pig-keeping used, now described, applies to one of the three farms but in general is similar to that found on the other two. However, it has been found that innovations which work on one farm do not necessarily work on the others. Pigs moved from one farm to another often suffer from diseases which must have been dormant in the pigs already there.

Farrowing is in Bunker type crates made of wood. They are in old Nissen huts. Some new farrowing pens with Ruarkura ring type crates have been used and found satisfactory. The young pigs are castrated, earmarked and de-tailed, to forestall tail-biting, at five days old. At seven days they are moved into the rearing houses. These are recently built at a cost of about £100 per sow place. They are in a single line with an internal connecting passage and those now being built with a single passage between two lines of pens will be cheaper per sow place. Drainage is by flooded drain. In the first type of house the drain runs under the passage and solids must be scraped into it. In the newer type the drain will run under a slatted floor at one side of the pen. Floors, walls and roofs are insulated. A creep with food is provided. Whey if available, is always on tap, from a constant level drinking bowl. Effluent from this and other buildings goes through a Sterovac drain and is pumped over much of the farm as liquid manure.

Dry sows are housed in pens of about 20. These are entirely indoors. No straw is used and they drain into a drain under the central passage. Whey is available ad lib. at night, water during the day. The sows are fed daily in individual feeders in batches so that eight sows use each feeder. After feeding they go out into a yard for about half an hour when a catch boar is turned with them. If the boar is put in the pens these may be slippery and the boar fail to serve a sow. It is found that the sows are satisfactory on concrete all their lives but that if once turned out to grass, foot troubles occur when they are brought back on concrete. It appears that this is a feature of high rainfall areas.

Feeding pigs are housed in a variety of buildings on an old aerodrome. A variety of pen designs have been used. The most recent development is a den type with floor feeding. In future buildings the front parts will have a slatted floor. At present they drain into a flooded drain under the passage. This needs some work with a squeegee.

When first weaned the pigs are fed twice daily but as soon as possible at the pigman's discretion they are changed to once-daily feeding. It was found that the pigs lay quieter fed only once. Also the quicker feeders get their fill and stop so that other pigs also get a fair share. Meal is increased as soon as possible to 2½ lbs. per head per day and not increased beyond that. Whey is fed ad lib. If whey is not available 5½ lbs. of meal are fed.

About 8 pigs per litter are weaned. Rather under two litters per sow are obtained. Age at bacon-weight is about 190-200 days on average. Post-weaning deaths are rather over 5% which seems to occur commonly with whey feeding. 12 men can look after the 500 sows and all their progeny. A profit of about 13% of output overall is obtained.

This pig enterprise is large because of the circumstances under which it was formed. Its purpose is to utilise a by-product for which at times there is no other outlet. Although the pigs are charged on average 0·8d. per gallon of whey, this representing a price ranging between ¼d. and 2d. per gallon, plus haulage on two of the farms, there are times when in fact the opportunity cost of the whey is negative as it would be expensive to dump it. There do not seem to be any particular economies to scale. In fact this enterprise is so large that it needs an efficient Head Office which adds to the overheads. It also takes a considerable time to alter managerial decisions. Probably an independent farmer living on the job can do better than a managing director can do at relatively infrequent visits.

Herd 3

This pig enterprise is a fattening unit for which weaners or strong stores are bought-in. There are no breeding stock. The principal enterprise is a poultry packing plant and the offal from this is used as pig feed. There is no other outlet for this at present so the food costs are very low. In addition swill from a holiday camp is purchased, at about £7 per ton, and a small quantity of barley meal added.

Those pigs which when bought are too small to go straight on to the offal and swill mixture are put into a weaner pool and introduced to it gradually. The main piggery is a large new building with a slatted dunging passage. The central feeding passage is wide to allow access with a trailer to deliver the food. This has proved a mistake as the resultant large airspace does not heat up in the winter. In addition the roof of the dunging passage allows draughts to enter.

The offal is sterilised by boiling and some fat skimmed off. In conjunction with another enterprise it is hoped to process the offal properly, reducing its fat level so that the resultant meal will keep. At this point it will be a saleable product and will have a true value.

About 40 pigs per week are sold as heavy hogs. Pigs are bought direct from farmers by personal contact.

This is an interesting example of the use of a by-product which would otherwise be wasted, and of an enterprise which has every reason not to breed its own weaners but to continue purchasing them.

Herd 4

This pig herd is of 145 sows running outside on the extensive

system. The climate is harsher than normally associated with this system.

The sows come from Wessex cross Landrace stock but have been largely bred to Landrace boars and there is now comparitively little "blue" blood. It is considered that this makes them more difficult to manage but improves the grading quality of their progeny which are sold to producers of bacon-weight pigs.

105 of the sows farrow in the spring and autumn and 40 sows farrow in the summer and winter. The winter farrowing is in arks drawn into the yards.

The system of management is identical with other herds run extensively. The farrowing huts are more weather-proof than those used further South but are also smaller and only cost 12gns. which is comparable with others.

One man with the help of a part-time crofter at lambing time looks after the sows and 300 ewes. Feeding is done from a special hopper mounted on the hydraulic lift of a tractor.

The farm is 500 acres of which 300 are corn and 50 potatoes. Apart from a poultry flock with one full-time poultryman the 300 ewes and 150 sows comprise the livestock. It is planned to increase the sows at the expense of the ewes. There are two other full-time men on the farm.

Food is bought-in at £31.15.0d. per ton (£38.10.0d. for the creep food). Labour costs £4 per sow per annum. 8-9 pigs are sold per sow at 2/4d. per lb. up to 60 lbs. and 1/4d. thereafter. Normal selling weight is 75 lbs. Some gilts are sold for breeding. This increases the profit appreciably. If this is done about £40 per sow per annum profit is made but if no gilts are sold it is only about £30.

Herd 5

This pig unit is a rather special case. The farm is only 43 acres, all grass, on the edge of a seaside town. 25 cows and their followers are kept and milk is bought-in in addition, to make Devonshire cream. There is thus a supply of skim milk available on the farm as a by-product. The farm buildings were originally built as the "home farm" of a large house with kennels and the like and these have been converted for the pigs. The kennels are particularly suitable for weaners.

Weaners are bought by weight direct from known farmers. There is one pigman. Straights are bought and much of the barley is home-grown on another farm. There is a mill-and-mix plant. The pigman gets help with weighing only. All the produce, about nine hundred

per annum, are sold as heavy hogs. Mucking out is by slats, sludge pit and tanker, which causes some problems with urban neighbours.

This is an enterprise quite clearly designed to use a by-product profitably. The primary enterprise is the cream production.

Herd 6

This pig enterprise is on only twelve acres in a low-lying coastal market garden area near holiday resorts and high production areas. The land is free-draining. The sole enterprise is fattening pigs to heavy hogs, weaners being purchased. They are fed swill and bread waste. The buildings are largely fairly simple conversion with insulation as needed. Mucking out is by squeegee or by overhead bucket.

The whole point of the enterprise is the cheap source of food. If collected in small lots it can be obtained very cheaply indeed. The only vulnerability is the incoming weaners. These can tend to become expensive and also may bring in disease.

The turnover is about 50 pigs per week. Four men and one youth are employed, looking after an average of 1,200 pigs.

The whole significance of this enterprise is that it utilises a source of cheap food available at this point through special circumstances, using very little land which at this point is in short supply.

IV

CONCLUSIONS

Pigs are kept on almost all types of farms and in all parts of the country. The only areas where they are relatively uncommon are the mountainous areas such as in Wales, the Scottish Highlands, the uplands of the Border, the fells, and on the moors of the South West. Pigs being essentially a supplementary enterprise, this is in no way surprising. It is suggested that such differences as do occur may be due to cheap food and cheap labour. This results in pigs being associated with barley growing on the one hand and with dairying and small farms on the other.

The most obvious change taking place is in size of herd, which is rapidly increasing. There are more large herds, about the same number of medium-sized herds and fewer small herds. Furthermore, there are indications that the smallest herds go out

of production in times of low prices and cause the slump in pig numbers seen in the "pig cycle".

It is pointed out that this increase in size need not imply "economies to scale" unless perhaps "management" is included as a cost. On the contrary, unless there are diseconomies to scale it is difficult to see why there should be any limit to the size of herd.

Various factors influencing cost are examined in relation to size of enterprise. There is no evidence that efficiency standards such as conversion rate, farrowing index, litter size and the like are linked with size of enterprise. The cost of food depends largely on the source from which it is obtained. It is suggested that food costs are at their lowest on a cereal-producing farm grinding its own corn or where some cheap source of food, such as swill, is available. While a reasonable size of herd is necessary in order to take advantage of either of these it appears that beyond that size few further economies are available.

While it is true that savings in labour costs can never offset disadvantages due to high food costs, it does not appear that low labour costs may imply any loss of efficiency. Given equal food costs the enterprises with low labour costs will have an advantage. It is more likely that labour costs will be low due to complementarity with another enterprise in this respect than due to size of pig enterprise, but there are cases of economies to scale in labour costs occuring from time to time. It is suggested that as it becomes essential to eliminate drudgery of jobs such as mucking out and of feeding at weekends these economies may be more important.

There are some indications that disease risks are higher in larger herds but as disease control is improved, particularly if the snags connected with the production of minimal disease pigs by hysterectomy are overcome, these risks may be reduced.

There are few indications of advantages to large pig herds in capital costs, selling price and genetic improvement.

Vertical integration and the related subject of "factory farming" have been exciting much interest in farming circles recently. It is often suggested that the pig industry will be entirely taken over by such interests. It is hard to see why this should be so. Perhaps the strongest influence towards such developments is the need for processors and large retail chains to ensure their supplies. But there are enough reasons against their doing so by entering pig production for themselves to encourage them to look for alternative methods of achieving their object. The farming community is becoming progressively readier to accept the dis-

ciplines of contracts and of buying and selling groups. It seems likely that a processing firm, by working through such groups and by building up the loyalty of its suppliers, should be in at least as strong a supply position as the integrated firms.

Looking to the future it seems that given steady increases in efficiency on all fronts the over-riding consideration is likely to remain a supply of cheap food and it is difficult to see how this can be better obtained than in the barley producing areas and in addition those special areas where food such as swill is available. The future of those small herds which pay high prices for their food looks very bleak, at least so far as fattening pigs are concerned. With breeding sows, labour costs and housing become more important and may enable them to continue. There will no doubt be a tendency for small uneconomic farms to remain in being due to personal preference and perhaps political policy. Even with the low labour costs that this might imply, it is difficult to see how they will compete with large scale extensive systems of sow keeping which are also economical in labour.

It might be thought that this would lead to a progressive concentration of pigs in the traditional cereal keeping areas but it is possible that this will not occur. Cereal production is being taken into higher rainfall areas and if methods can be developed of feeding grain to pigs without drying it, they might become an attractive way of utilising grain in these areas. In this way they may continue to be associated with small scale dairy farming.

Large pig herds will no doubt continue to increase in size and number, but there is no reason to suppose that herds of moderate size on mixed farms will be pushed out of production. Their possible advantages are too great. The real expert with pigs will no doubt expand his herd up to the limit of his resources and abilities but he, like everyone else, is mortal and one more dispersal sale will leave room for others to expand. The day when the joint-stock company takes over agriculture is not yet come.

APPENDIX I

Table 1

THE CONTRIBUTION OF PIGS TO OUTPUT BY FARMING TYPE (ENGLAND AND WALES)

Type of Farming Area		Pig Output per £100 Total Gross Output
Predominantly Livestock	S.W. Moorland (incl. Exmoor, Dartmoor)	6·21
	S.W. Shropshire and W. Hereford	5·07
	Wales, better land	3·98
	Wales, poor land	0·35
	Northern	0·09
Livestock Fattening	S. Northumberland	4·13
	Midland	4·02
Livestock with Substantial Dairying	N. Devon and N.E. Cornwall	10·33
	Wales, better land	6·73
	Solway Plain	2·52
	N. Central Pennines	2·17
	Wales, poor land	1·22
Dairying	Cheshire and N. Shropshire	11·29
	Severn Vale and Somerset Dairying	10·05
	N. Dorset and Wiltshire Vale	8·50
	E. Devon and W. Dorset	8·26
	Wales	5·86
	Northern Dairying	4·76
	Yorks. and E. Lancs	4·74
	N.W. Derby and N.E. Staffs.	3·82
	Kent and Surrey	2·90
Mixed with Substantial Dairying	Sussex	8·58
	S. Essex	7·25
	Clay Vales (Bucks., Oxford, Berks.)	4·46
Crops and Livestock	Central Suffolk	18·57
	Holderness	17·70
	Vale of York	14·33
	West Midland	11·69
	Yorkshire Wolds	7·43
General Mixed	South Western	18·09
	Northern	9·44
	Midland	8·42
	S. Eastern	7·52
	Cotswolds and S. Chalk Upland	6·81
Light Land Arable	S. Cambs. Chalk	8·90
	Lindsey and Kesteven Limestone	4·39
	Lincolnshire Wolds.	2·69
Other Arable	W. Cambs. and Hunts.	12·95
	S. Suffolk and N. Essex	11·63
	Central Norfolk Loam	9·44
Alluvial Arable	Fen District and Lincoln Warp	7·01
	S.W. Lancashire	4·84
Specialist Types	Market Garden	4·21
	Poultry	3·64
	Pigs and Poultry	42·59

Source : P.A.E.S. Farm Management Survey 1954-60.

Table 2 Appendix I

THE CONTRIBUTION OF PIGS TO OUTPUT BY FARMING TYPE (SCOTLAND)

Type of Farming Area	Percentage of Total Gross Output coming from Pigs
Livestock and arable. Intensive (pigs and poultry important)	11·07
Cropping	6·06
Dairy	4·26
Livestock and arable. Not intensive (pigs and poultry unimportant)	3·21
Upland rearing	0·67
Hill sheep	0·22

Source : Scottish Agricultural Economics, Vols. XI, XII and XIII. Results for years 1958/9 - 1961/2

APPENDIX II

SOME RESULTS OF THE QUESTIONNAIRE SENT TO FARMERS WITH LARGE PIG HERDS

Table 1

THE NUMBER OF LARGE SCALE PIG ENTERPRISES FOUND IN EACH TYPE OF FARMING AND TYPE OF PIG PRODUCTION

Type of Farm \ Type of Pigs	Fattening	Breeding and Fattening	Mainly Stores and Weaners	TOTAL
Pigs only	14	19	4	37
Pigs and Poultry	2	6	1	9
Dairy and Pigs	15	12	5	32
Arable and Pigs	2	15	3	20
Arable & Pigs & Poultry	–	4	1	5
Mixed. Cattle and Sheep	6	17	2	25
Mixed. Sheep no Cattle	2	6	5	13
Mixed. Cattle no Sheep	2	9	–	11
TOTAL	43	88	21	152

Table 2 Appendix II

SOW FEEDING METHOD BY SOW MANAGEMENT SYSTEM

System: In pig / Farrowing / Rearing	Indoor Indoor Indoor	Seasonal * Indoor Indoor	Outdoor Indoor Indoor	Outdoor Indoor Outdoor	Outdoor Outdoor Outdoor	Undefined Mostly Outdoor	Undefined Mostly Indoor	TOTAL
Number of herds	33	15	23	4	20	12	2	109
Percentage fed :–								
Nuts	30%	20%	48%	50%	75%	50%	50%	44%
Nuts and Meal	12%	40%	17%	50%	25%	42%	50%	25%
Meal	57%	40%	35%	0%	0%	8%	0%	31%
Percentage of each management system selling stores or weaners	15%	13%	13%	25%	45%	8%	0%	19%

* Seasonal – Indoor winter. Outdoor summer.
See Longbottom (1963) Weaner pig production,
University of Exeter, Department of Economics (Agricultural Economics).

Table 3

Appendix II

FEEDING SYSTEM BY FARM TYPE

PERCENTAGE OF EACH FARM TYPE USING VARIOUS FEEDING SYSTEMS

Type of Farm \ Feeding	Buy in ready mixed compounds	Buy in straights	Buy in ready mixed concentrate additives	Grind own corn	Dairy By-products
Pigs only	22%	76%	32%	70%	26%
Pigs and Poultry	22%	89%	11%	44%	22%
Dairy and Pigs	22%	66%	47%	78%	44%
Arable and Pigs Arable and Pigs and Poultry	24%	68%	72%	88%	16%
Mixed. Cattle and Sheep Mixed. Sheep no Cattle Mixed. Cattle no Sheep	35%	61%	47%	73%	39%
All Farms	26%	68%	45%	74%	32%

Table 4

Appendix II

FEEDING SYSTEM BY TYPE OF PRODUCTION

PERCENTAGE OF FARMS OF A GIVEN TYPE OF PIG PRODUCTION THAT USE VARIOUS FEEDING METHODS

Feeding / Type of Pigs	Buy in ready mixed compounds	Buy in straights	Buy in ready mixed concentrate additives	Grind own corn	Using milk by-products				Using "bulky" foods			
					Skim	Whey	Both	Total	Potatoes	Swill	Both	Total
Fattening	21%	70%	37%	74%	9%	21%	5%	35%	0%	7%	7%	14%
Breeding and Fattening	23%	72%	48%	75%	27%	6%	2%	35%	10%	2%	0%	12%
Mainly Stores and Weaners	52%	52%	52%	71%	10%	0%	0%	10%	0%	0%	0%	0%

Table 5. Appendix II

DISEASE OCCURRENCE BY TYPE OF PRODUCTION

Percentage of herds of each type of production that had an outbreak of disease.

	Virus pneumonia	Swine fever
Fattening	53%	42%
Breeding and Fattening	24%	20%
Mainly Stores and Weaners	19%	5%
Total	32%	24%

Table 6. Appendix II

HOUSING SYSTEMS

Percentage of herds using various types of fattening house.

Danish	44%
Controlled Environment	30%
Deep Litter	18%
Sweat Box	2%
Harper Adams	18%
Any other type	56%
None	7%

Table 7. Appendix II

MUCK HANDLING METHODS

Percentage of herds of each type of production using each type of muck handling.

	Fattening	Breeding and Fattening	Total
Slats and Sludge Pit	37%	32%	34%
Other mechanical means	37%	56%	50%
By hand	63%	75%	71%
By hand only	30%	23%	25%

Table 8. Appendix II

GROWTH IN SIZE

Percentage of herds that have grown in size over the period 1957-63.

Fattening	70%
Breeding and Fattening	83%
Stores and Weaners	67%

APPENDIX III

The term multiple correlation and certain other related statistical terms are used in this report. There follows an attempt to explain the more important. However, those who wish to understand them fully should consult such books as "Facts from Figures" by M. J. Moroney, (Pelican Books), "Applied Statistics" by Croxton and Cowden (Pitman) and "Methods of Correlation Analysis" by M. Ezekiel (John Wiley & Sons).

Multiple correlation is a mathematical method of expressing a relationship between one variable, in this case the number of pigs, and other variables which may be connected with it. Simple correlation expresses the relation between two variables only.

If y = pints of liquid

and x = gallons of liquid

$$y = 8x$$

This relationship is simply a matter of definition. But there are relationships which are not so close as this. It is well known that pigs use large quantities of barley for food and therefore in counties where barley is grown pigs might be kept. This relationship can also be shown as an equation

$$y = a + bx$$

where y is the number of pigs in the county and x the acres of barley. Thus if there were 10,000 acres of barley there would be (a + 10,000b) pigs. The value of a is the number of pigs in a county with no barley. But of course this relationship is not exact. It merely expresses the influence that barley acreage has on pig numbers.

The closeness of the relationship is measured by the coefficient of determination, r^2 (r is the coefficient of correlation), which can have values between 0 and 1. A value of 0 means there is no relationship between y and x while 1 describes an exact relationship such as that between pints and gallons. The closeness of the relationship can also be expressed as a percentage. If it is said that 50% of the variation in pig numbers is explained by the variation in barley acreage this only means the coefficient of determination (r^2) equals 0·50.

But any one factor can be affected by several other factors simultaneously. In this case the suggestion is that pig numbers (1) might be related to milk production (2), barley (3), sheep numbers (4), and farm size (5).
Then the equation would look like this :–

$$X_1 = a + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5$$

This whole equation has a coefficient of multiple determination (R^2). However we are interested in the relative importance of these other factors in explaining pig numbers. This can be done by the coefficient of partial determination which as above can be expressed as a percentage or by the beta regression coefficient. These two measure roughly the same but their mathematical definitions are different.

The questions of standard error and confidence limits are too complex to treat here and those interested must consult the text books. However 95% confidence means that 95% of the observations fall within certain limits or that there is one chance in twenty that the figure in question falls outside these limits. This is usually shown by a single asterisk, thus $r^2 = 0{\cdot}8*$. 99% and 99·9% confidence are conventionally shown by two and three asterisks respectively. When it is said that a measure such as a coefficient of determination is "significant" at the 95% level it means that there are nineteen chances in twenty that it is different from zero. It does not mean that there is only one chance in twenty that it is not exactly right.

The above is very much condensed and those interested are again urged to consult the appropriate texts.

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